

MARINE LITTORAL COLLEMBOLA OF NORTH AND CENTRAL AMERICA

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ABSTRACT

The 18 known species of marine littoral Collembola of North and Central America are reviewed, and 8 new species described: *Anurida* (A.) *ashbyae*, *Anurida* (A.) *mara*, *Brachystomella honda*, *Friesea rothi*, *Friesea carlota*, *Isotoma* (Halistoma) *marisca*, *Isotoma* (Psammisotoma) *dispar*, *Seira nicoya*. Four other species are recorded from this region for the first time. The ecology and biogeography of the marine Collembola of the region are discussed.

The presence of Collembola in the marine littoral zone of North America has been known for over a century, beginning with records of *Anurida maritima* by Verrill and Smith (1872) and Packard (1873), and the description of *Archistoma besselsi* by Packard (1877). The most substantial later references are to embryology of *A. maritima*, by Ryder (1886), Claypole (1898), and Folsom (1900), and to the ecology of this and other species, by Davenport (1903a) and Conrad (1977). North American literature otherwise includes only taxonomic descriptions in papers by Folsom (1902; 1916; 1917; 1937), Bacon (1912; 1913; 1914), Christiansen (1956; 1958), Christiansen and Bellinger (1974; 1980-1981), and Parisi (1972), and scattered locality records, mostly of the first two species and mostly incidental. The biology of littoral Collembola in general is covered by Joosse (1976), and many species are described in Christiansen and Bellinger (1980-1981).

Our intent here is to review present knowledge of the littoral Collembola of the continental coasts north of Panama, and to describe some new species and records. The fauna of the Caribbean islands is evidently rich, but we have seen little material from that region and include here only a few records of species also known from the continent or the Florida Keys.

The new material on which much of this work is based was collected largely by Vincent Roth and his collaborators along the coasts of Sonora, Mexico, and by the senior author during a collecting trip to the Florida Keys. The great diversity of species found in these two areas suggests that many more will be found when collections are made in other parts of the region.

SPECIES LIST

The following is a list of Collembola of the area which are primarily or exclusively marine littoral species from Continental North and Central America. Those marked with an asterisk are new records from the region or new species being described here or elsewhere. Letters and numbers indicate localities (Fig. 1).

Family HYPOGASTRURIDAE

- Hypogastrura* (H.) *litoralis* (Linnaniemi, 1909). A
- Xenylla* (Paraxenylla) *affiniformis* Stach, 1929. 5
- **Brachystomella honda* new species. 5
- **Friesea carlota* new species. 5
- Friesea fara* Christiansen and Bellinger, 1974. B
- **Friesea rothi* new species. 3 and 4
- Oudemansia georgia* Christiansen and Bellinger, 1980. C
- **Pseudanurida sawayana* Schuster, 1965. 5

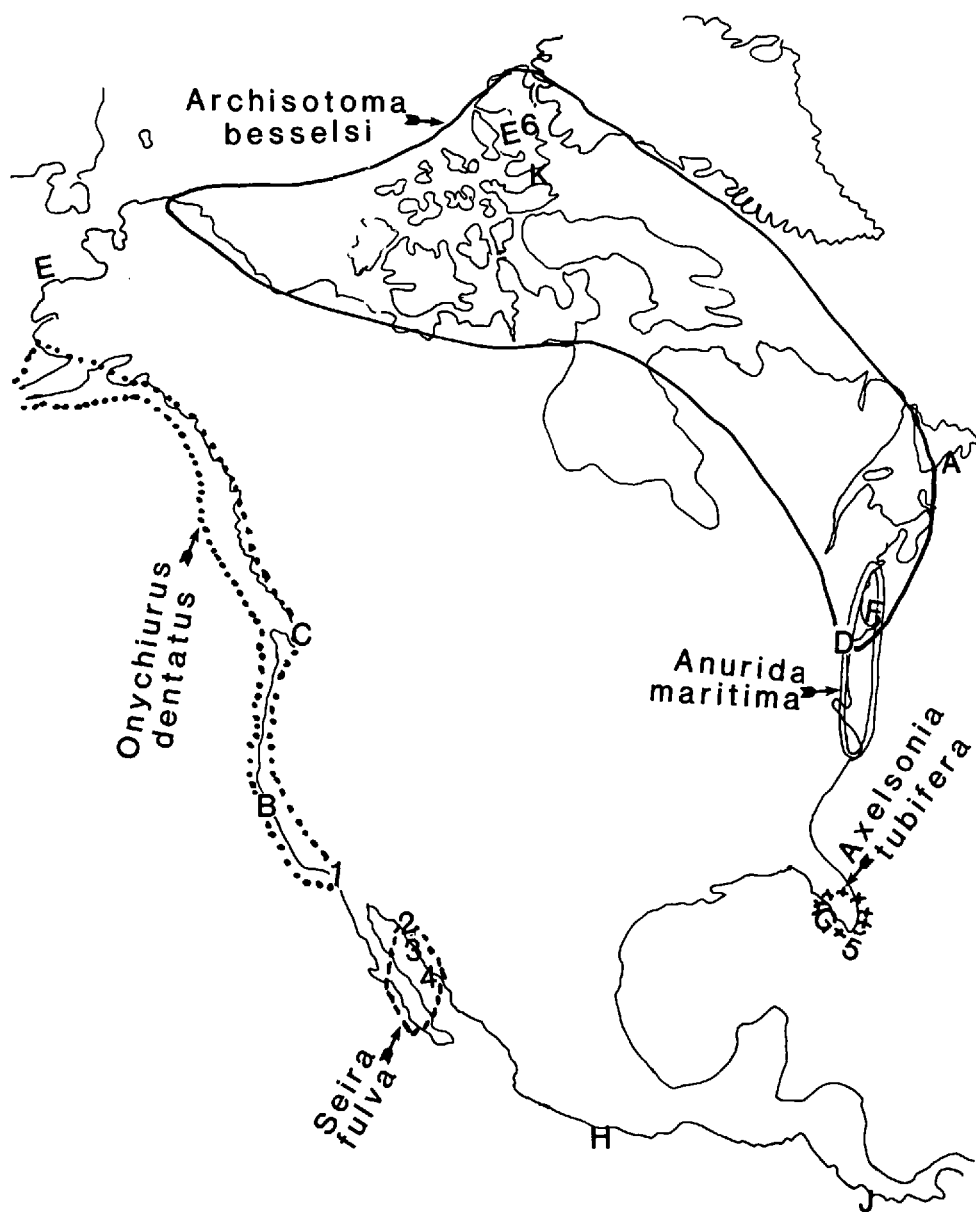


Figure 1. Distribution of collections of Nearctic mainland littoral collembola. Doubtful localities not included. Probable continuous distributions of five species. Letters = localities with one species. Numbers = localities with 2+ species. *Hypogastrura littoralis*—A., *Friezea fara*—B., *Oudemansia georgia*—C., *Anurida calcarata*—D., *Onychiurus debilis*—E and 6., *Onychiurus litoreus*—F., *Anurida ashbyae*—G and 5., *Actaetes boneti*—H., *Anurida mara*—J., *Actaetes polaris*—K and 6., *Archisotoma interstitialis* 1, 2, 3, and 4., *Isotoma marisca*—*Entomobrya arula*—1., *Entomobrya laguna*—1., *Pseudosinella lahainensis*—2., *Friezea rothi*—3 and 4., *Actaetes* N. sp.—3., *Siera nicoya*—3 and 4., *Pseudanurida sawayana*—5., *Isotoma dispar*—5.

- **Anurida* (*A.*) *ashbyae* new species. G and 5
Anurida (*A.*) *mara* new species. T
 **Anurida* (*A.*) *maritima* (Guerin, 1838). See Figure 1.
Anurida (*Anuridella*) *calcarata* (Denis, 1925). D

Family ONYCHIURIDAE

- Onychiurus* (*Protaphorura*) *debilis* (Moniez 1889). E and G.
Onychiurus (*Protaphorura*) *litoreus* Folsom, 1917. F
Onychiurus (*O.*) *dentatus* (Folsom, 1902). See Figure 1.

Family ISOTOMIDAE

- Actaetes boneti* Parisi, 1972. H
 **Actaetes* new species. 3
Archisotoma besselsi (Packard, 1877). See Figure 1
Archisotoma polaris Fjellberg and Poinsot, 1975. K and 6
 **Archisotoma interstitialis* Delamare, 1954. 1, 2, 3, and 4
 **Isotoma* (*Psammisotoma*) *dispar* new species. 5
 **Isotoma* (*Halisotoma*) *marisca* new species. 1

Family ENTOMOBRYIDAE

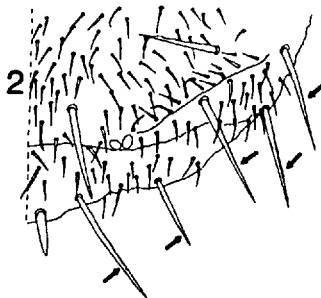
- Entomobrya* (*E.*) *arula* Christiansen and Bellinger, 1980. 1
Entomobrya (*Mesentotoma*) *laguna* Bacon, 1913. 1
 **Pseudosinella lahainaensis* Christiansen and Luther, 1986. 2
 **Seira nicoya* new species. 3 and 4
Seira fulva (Schött, 1896). See Figure 1.

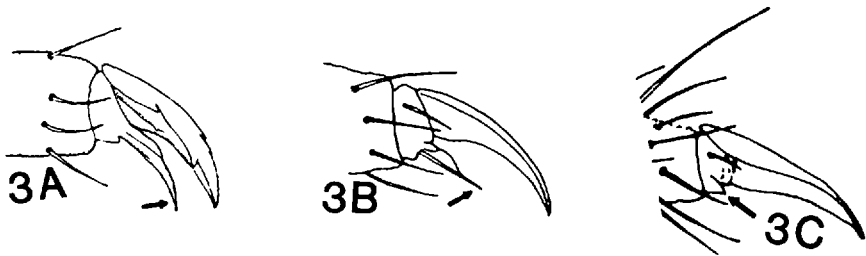
Figure 1 shows the known distributions of these species. Concentration of records in a few areas, and the long sections of coastline without records, certainly reflect localization of collections and not the true distribution of the fauna.

The illustrated key below will serve to separate the known species.

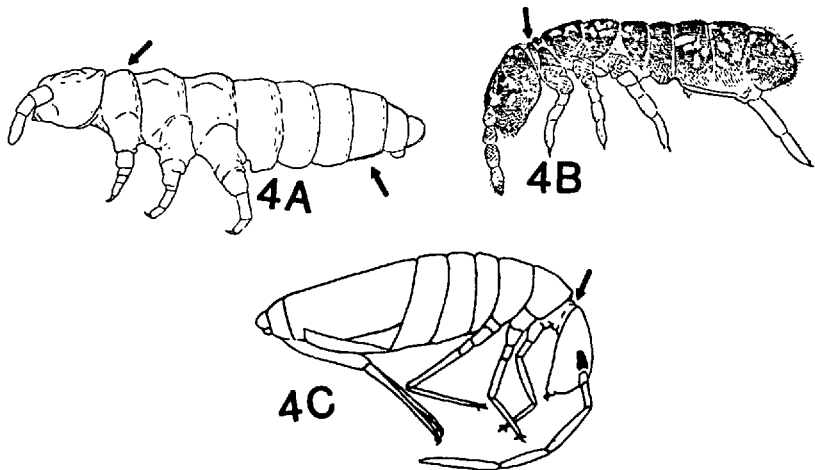
KEY TO PRIMARILY OR EXCLUSIVELY MARINE COLLEMBOLA OF NORTH AND CENTRAL AMERICA

- | | |
|---|----------------------------|
| 1a. Without pigment or eyes | 2 |
| 1b. With pigment and eyes | 5 |
| 2a. Body with large spinelike setae (Fig. 2); foot with unguiculus more than half as long as inner edge of unguis (Fig. 3A) | <i>Onychiurus dentatus</i> |
| 2b. Body without spinelike setae; foot with unguiculus about half as long as inner edge of unguis (Fig. 3C) or absent (Fig. 3C) | 3 |





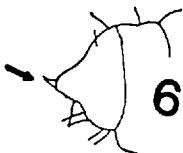
- 3a. Unguiculus absent (Fig. 3C) *Anurida calcarata*
- 3b. Unguiculus present (Fig. 3B) 4
- 4a. First 3 abdominal segments each with 1+1 pseudocelli *Onychiurus litoreus*
- 4b. First 3 abdominal segments each with 3+3 pseudocelli *Onychiurus debilis*
- 5a. First thoracic segment well developed (Fig. 4A), with dorsal setae 6
- 5b. First thoracic segment greatly reduced compared to second (Fig. 4B, C), without dorsal setae 16



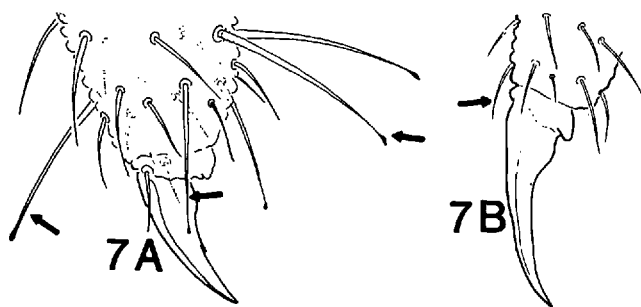
- 6a. Furcula well developed (Fig. 5A) 7
- 6b. Furcula absent or vestigial (Fig. 5B) 11



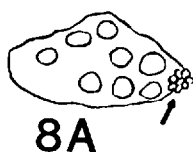
- 7a. With distinct anal spines (Fig. 6) *Hypogastrura litoralis*
- 7b. Without anal spines 8



- 8a. Foot with one or more clavate tenent hairs (Fig. 7A) 9
- 8b. Without clavate tenent hairs (Fig. 7B)10



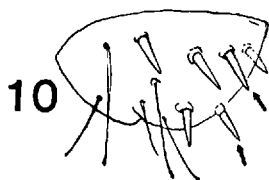
- 9a. Postantennal organ present (Fig. 8A); foot with one clavate tenent hair *Brachystomella honda*
 9b. Postantennal organ absent (Fig. 8B); foot with 3–5 clavate tenent hairs *Xenylla affiniformis*



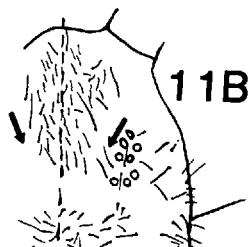
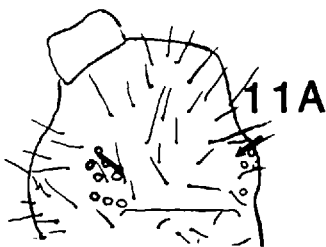
- 10a. Dens less than 3 times as long as mucro (Fig. 9A) *Oudemansia georgia*
 10b. Dens more than 4 times as long as mucro (Fig. 9B) *Pseudanurida sawayana*



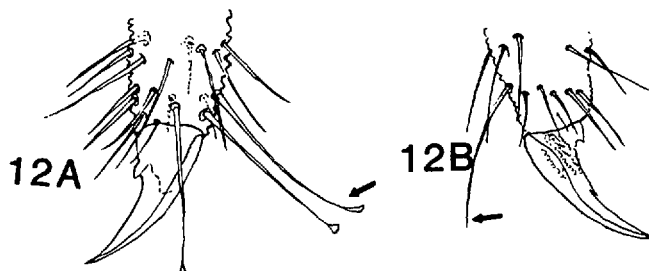
- 11a. With distinct anal spines (Fig. 10) 12
 11b. Without anal spines 14



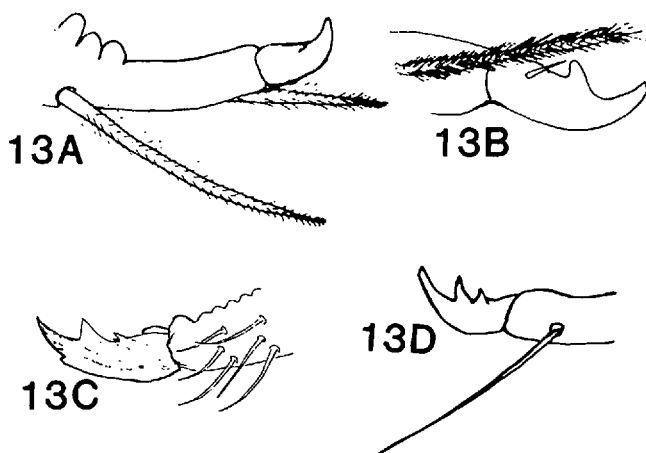
- 12a. Furcula small but present (Fig. 5B) *Friesea fara*
 12b. Furcula absent 13
 13a. With 14 or fewer setae in the quadrangle between the most anterior eyes and the posterior margin of the head (Fig. 11a) *Friesea carlota*
 13b. With more than 24 setae in this quadrangle (Fig. 11B) *Friesea rothi*



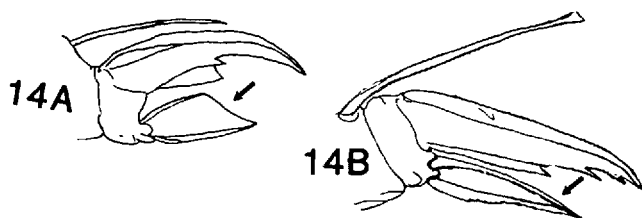
- 14a. Tenent hairs clavate (Fig. 12A) *Anurida mara*
 14b. Tenent hairs acuminate (Fig. 12B) 15



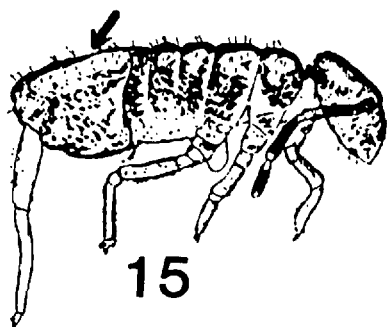
- 15a. First antennal segment with 13–14 setae *Anurida maritima*
 15b. First antennal segment with 16–17 setae *Anurida ashbyae*
 16a. Mucro a simple hook (Fig. 13A) 17
 16b. Mucro with 2 or more lamellae or teeth (Fig. 13B, C, D) 18



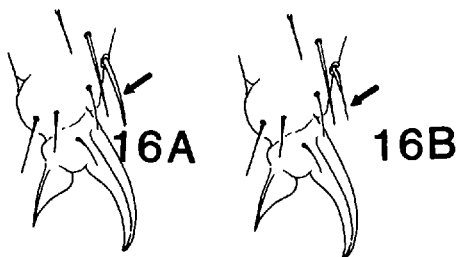
- 17a. Pigment limited to eyes and antennae *Seira fulva*
 17b. Body with irregular blue pigment bands *Seira nicoya*
 18a. Mucro bidentate (Fig. 13B) 19
 18b. Mucro with 3 or more teeth or lamellae (Fig. 13C and D) 21
 19a. Head and body scaled *Pseudosinella lahainaensis*
 19b. Scales absent 20
 20a. Unguiculus obliquely truncate (Fig. 14A) *Entomobrya laguna*
 20b. Unguiculus lanceolate (Fig. 14B) *Entomobrya arula*



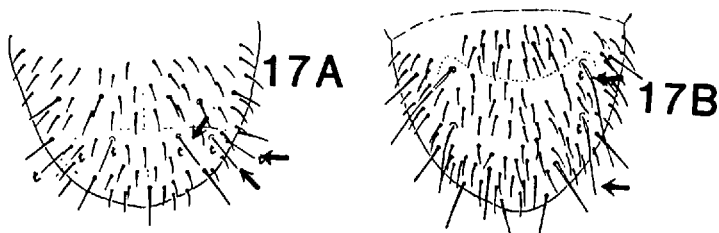
- 21a. Last 3 abdominal segments fused and about as long as rest of trunk (Fig. 15) 22
 21b. Not as above 23



- 22a. Male metatibiotarsus with internal spur *Actaletes boneti*
 22b. Male metatibiotarsus without internal spur *Actaletes* n. sp.
 23a. Manubrium with many ventral (anterior) setae 24
 23b. Manubrium without ventral setae 26
 24a. Mucro quinquedentate *Axelsonia tubifera*
 24b. Mucro tridentate (Fig. 13D) 25
 25a. Inner apex of basal antennal segment sharply angled *Isotoma marisca*
 25b. Without such angles *Isotoma dispar*
 26a. Third tibiotarsus with apical dorsal seta thickened (Fig. 16A) 27
 26b. Third tibiotarsus with apical dorsal seta fine (Fig. 16B) *Archisotoma polaris*



- 27a. Sixth abdominal segment with 3+3 bothriotricha (Fig. 17A) *Archisotoma besselsi*
 27b. Sixth abdominal segment with 2+2 bothriotricha (Fig. 17B) *Archisotoma interstitialis*



SYSTEMATICS

Xenylla (*Paraxenylla*) *affiniformis* Stach, 1929

Xenylla affiniformis Stach, Annls. hist.-nat. Mus. natn. hung 26: 280 (Buccari, Hungary)

Haloxenylla affiniformis Gama and Deharveng, 1984: 131

Xenylla (*Paraxenylla*) *mangle* Murphy, 1965: 392 (Kombo St. Mary, Gambia)

This remarkable species is easily identified. Our specimens agree completely with those described by Gama and Deharveng (1984). The replacement of *Haloxe-*

nylla by *Paraxenylla* is required because their type species are synonyms (confirmed by Gama, in litt).

This species occurs in the intertidal zone on rocks and algae, and in wet litter on the littoral fringe. There is one earlier record from the North American continent (Culik and Deharveng, 1986).

New Locality.—Florida: Monroe Co., Pigeon Key, 3 and 4 Jan 1985.

***Brachystomella honda* new species**

Figure 18, Table 1

Holotype.—MCZ 33323. No. 6507 collected Atlantic Side, Bahia, Honda Key, Monroe Co., Florida, rocky flats sifting litter at edge.

Description.—Color gray-blue, with ventral surface and intersegmental membranes paler. Fourth antennal segment with apical bulb narrow and deeply withdrawn into apex, and without differentiated blunt setae. Last 2 antennal segments weakly separated. Apical organ of third antennal segment composed of 2 blunt pegs exposed in shallow pits and 2 slightly differentiated guard setae. Labrum with clear apical papillae and 4 short curved setae; 2+2 prelabral setae just before papillae, and 3+3 or 4+4 in 2 lateral clusters. Maxilla normal for genus, with 8 teeth. Labium with 10+10 setae in area of labial triangle and 5+5 lateral of these. Postantennal organ of 5–7 lobes, subequal in size to one eye. Eyes 8+8, subequal. Tibiotarsus with a basal whorl of 7 (rarely 6) setae and a distal whorl of 11, including one straight, acuminate to weakly clavate tenent hair, slightly longer than other setae. Unguis with minute lateral teeth and clear inner tooth. Ventral tube with 3+3 large, subequal lateral setae. Tenaculum with 3+3 teeth. Dens with 4 dorsal setae. Mucro about half the length of dens, tapering from a strongly swollen base which is smooth on inner side and coarsely tuberculate on outer side. Female genital plate with 8–15 setae in a curved band. Males not seen. Body coarsely granulate; granules roundly conical and about 3 micra in basal diameter. Body setae all smooth and acuminate; longest setae about 0.03 mm. Maximum length 1.5 mm.

Remarks.—The combination of number of postantennal organ lobes, dental setae, and tenent hairs distinguishes this species from most other members of the genus. Similar species are *B. platensis* Najt and Massoud, 1974, with different dental chaetotaxy and mucro and eyes farther apart than in *B. honda*, and *B. baconaoensis* Gruia, 1983, which has a sharply pointed mucro without basal tubercles and distinct antennal blunt setae. In one specimen from Pigeon Key there are 4 post-antennal organ lobes on one side but 7 on the other. On some specimens a short stout microchaeta is found just below the apex of the dorsolateral surface of the fourth antennal segment. The species shows no littoral adaptations.

Habitat.—Found only in litter near the high tide mark.

Type Locality.—Florida: Monroe Co., Bahia Honda Key, on rocky tide flats, 5 January 1985, holotype and 7 paratypes (K. Christiansen).

Additional locality.—Florida: Monroe Co., Pigeon Key, 5–6 January 1985 (K. Christiansen).

***Friesea carlota* new species**

Figure 19, Table 1

Description.—Color black except for gray intersegmental membranes. Fourth antennal segment with an unlobed, deeply withdrawn apical bulb, 5 long, thick

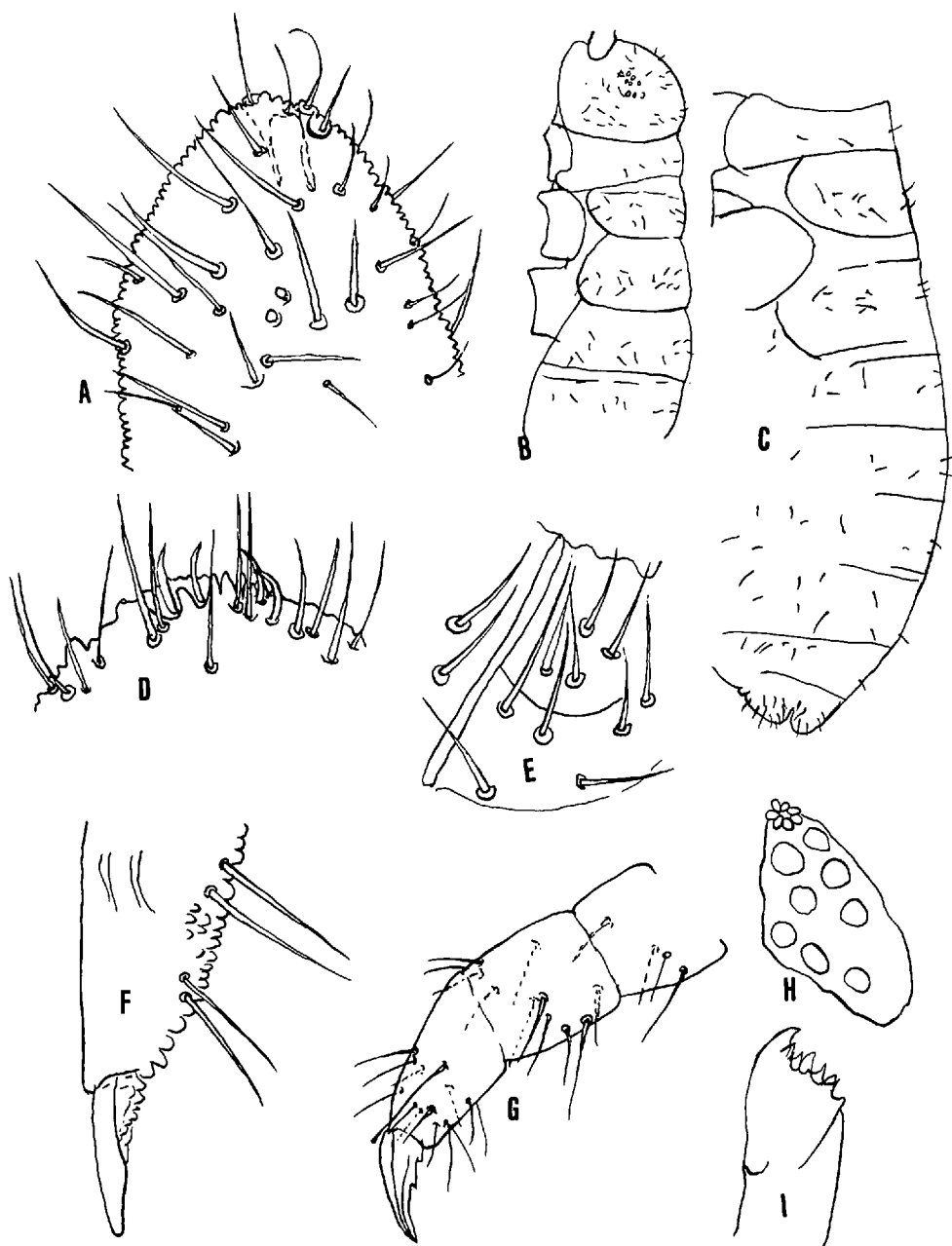


Figure 18. *Brachystomella honda*. A. Apex of antenna, holotype. B and C. Anterior and posterior dorsal chaetotaxy, paratypes. D. Labrum, specimen from Pigeon Key. E. Ventral labial triangle, left side, specimen from Pigeon Key. F. Dens and mucro, paratype. G. Hind leg, specimen from Pigeon Key. H. Eyes and postantennal organ, left side, same specimen. I. Maxilla, specimen from Pigeon Key.

Table 1. Measurement of holotypes of new species herein described

	Fourth antennal segment	Third antennal segment	Second antennal segment	First antennal segment	Cephalic diagonal	First thoracic segment	Third thoracic segment	Third thoracic segment
<i>Brachystomella honda</i>	0.05	0.03	0.03	0.03	0.26	—	0.07	0.08
<i>Brachystomella honda</i>	0.03	0.04	0.04	0.03	0.28	—	0.11	0.17
<i>Friesa carlota</i>	0.03	0.03	0.04	0.05	0.22	—	0.07	0.14
<i>Friesa rothi</i>	0.08	0.08	0.08	0.08	0.45	—	0.16	0.25
<i>Anurida ashbyae</i>	0.10	0.08	0.11	0.11	0.61	0.17	0.27	0.30
<i>Anurida mara</i>	0.072	0.084	0.111	0.111	0.593	0.20	0.28	0.335
<i>Isotoma (Psammisotoma) dispar</i>	0.15	0.125	0.10	0.055	0.27	—	0.18	0.18
<i>Isotoma (Halisotoma) marisca</i>	0.13	0.10	0.09	0.06	0.25	—	0.11	0.14
<i>Seira nicoya</i>	0.44	0.30	0.28	0.12	0.45	—	0.31	0.23

curving setae and 4 short, thick blunt setae (sometimes obscure). Third and fourth antennal segments fused dorsally but weakly separated ventrally. Apical organ of third antennal segment composed of 2 small bent pegs; no distinct accessory setae seen. Labrum not clearly lobed; prelabral setae 2-5-5. Mandible with 7 inner teeth and a thin, triangular basal lamella. Ventral maxillar lamella with 3 inner teeth and a small pluglike structure between the basal two; dorsal lamella much shorter and finely serrate. Labium not clearly demarcated but apparently with 9+9 setae. A smooth clear area in the usual position of the postantennal organ. Eyes 8+8, subequal. Tibiotarsi with 6 proximal (5 on third leg) and 10 distal setae; the distal whorl includes 5 long, clavate setae, one being longer and much more heavily clavate than the others. Unguis without teeth. Ventral tube with 4+4 setae. Furcula and tenaculum absent. 6 conical anal spines in anterior row of 4 and posterior row of 2. Body not plurichaetotic; all body setae smooth; longest posterior setae clavate, about 0.06 mm long and about 2-3 times as long as neighboring short setae. Maximum length 1 mm.

Remarks.—This species resembles *F. rothi* n. sp. (see below) in some respects, but differs strikingly in the shape of the mandible and maxilla and in having an unlobed apical antennal bulb. The one greatly enlarged tenent hair is a conspicuous feature of all specimens of *F. carlota* we have seen; this characteristic distinguishes it from *F. parva* Womersley, 1936, *F. ladeiroi* Gama, 1959, *F. salmoni* Massoud, 1967 (= *Colonavis grandis* Salmon, 1949). The mouthparts distinguish *F. carlota* from *Spinanurida mandibulata* Salmon, 1969.

Type Locality.—Mexico: Sonora, San Carlos Bay, on rocks covered with algae, 23 March 1974, holotype and 11 paratypes (W. Brown).

Friesa rothi new species

Figure 20, Table 1

Description.—Color gray; white background with black granules except on intersegmental membranes, ventral surface, and parts of the appendages. Fourth antennal segment with bilobed, deeply withdrawn apical bulb and 5 weakly differentiated, curved setae dorsally; these are about as thick as other setae, and, except for one, may not be clearly blunt. Third and fourth antennal segments clearly

Table 1. Continued

First abdominal segment	Second abdominal segment	Third abdominal segment	Fourth abdominal segment	Fifth abdominal segment	Sixth abdominal segment	Tibiotarsus	Manu- orium	Dens	Mucro	Tenent hair	Unguis	Unguic- ulus
0.17	0.09	0.09	0.28	0.04	0.03	0.07	—	—	—	0.03	0.03	0.005
0.14	0.28	0.09	0.33	0.06	0.05	0.04	—	—	—	0.02	0.02	0.01
0.13	0.14	0.15	0.25	0.08	0.06	0.06	—	—	—	0.02	0.03	0.01
0.28	0.23	0.22	0.40	0.08	0.07	0.08	—	—	—	0.03	0.07	0.03
0.22	0.22	0.19	0.17	0.17	0.19	0.17	—	—	—	—	0.095	—
0.28	0.30	0.28	0.22	0.17	0.09	0.17	—	—	—	—	0.06	—
0.13	0.13	0.12	0.14	0.08	0.075	0.12	0.16	0.27	0.02	0.02	0.03	0.02
0.14	0.10	0.15	0.28	0.08	0.08	0.10	0.16	0.28	0.01	0.02	0.03	0.02
0.17	0.21	0.20	0.69	0.16	0.11	0.42	0.50	0.60	0.06	0.08	0.04	0.03

separated. Apical organ of third antennal segment composed of 2 short, thick bent pegs and 2 longer conical pegs, one of which sometimes has a small, conical, basal accessory peg. Labrum without clear papillae; 2-5-5 smooth prelabral setae. Mandible with 7 inner teeth and an obscure, thin, projecting basal lamella. Ventral maxillar lamella with 2 teeth and a basal plug-shaped mass; dorsal lamella slender, with 14-17 fine inner teeth. Labium not clearly demarcated but apparently with 8+8 or 9+9 setae. A smooth area in the normal position of the postantennal organ. Eyes 8+8, subequal. Tibiotarsus with 7 basal (6 on third leg) and 11 distal setae, including 4-8 weakly to moderately clavate tenent hairs. Unguis without teeth. Ventral tube with 5+5 subequal smooth setae. Furcula and tenaculum absent. 4 or 6 heavy anal spines; posterior 4 in a quadrangle; anterior 2, if present, much farther apart than others. Body uniformly granulate; granules conical, 2-3 micra in basal diameter. Clothing plurichaetotic, of smooth acuminate setae; longest posterior setae about 0.09 mm long and 3-4 times as long as neighboring short setae. Maximum length 2.5 mm.

Remarks.—Specimens from the type locality and Punta Santa Rosa have 4 anal spines (although only the bases of some may be visible); those from the other 2 localities have 6 anal spines, and the tenent hairs are more strongly clavate. Acuminate and clavate tibiotarsal setae intergrade, so that it is difficult to determine how many are actually clavate.

The peculiar quadrate inner tooth of the maxilla is constant and characteristic of the species. *F. rothi* resembles *F. afurcata* Denis 1927, which has very different mouthparts, and can be distinguished from *F. salmoni* Massoud, 1967 (= *Colo-navis grandis* Salmon, 1939) by the bilobed antennal bulb and smaller number of clavate setae. Plurichaetosis is more extreme in *F. rothi* than in any other species we have seen; there is considerable asymmetry as well as individual variation. Two specimens had one of the anal spines apically divided.

Habitat.—Found under rocks and boulders in the intertidal zone of sandy beaches.

Type Locality.—Mexico: Sonora, Punta Cirio, 19-20 January 1974, holotype and 11 paratypes (V. Roth).

Additional Localities.—Sonora, Punta Santa Rose, 18 June 1976; Puerto de Lobos, 18 March 1969 (V. Roth); Tastiota, 29 April 1979 (V. Roth).

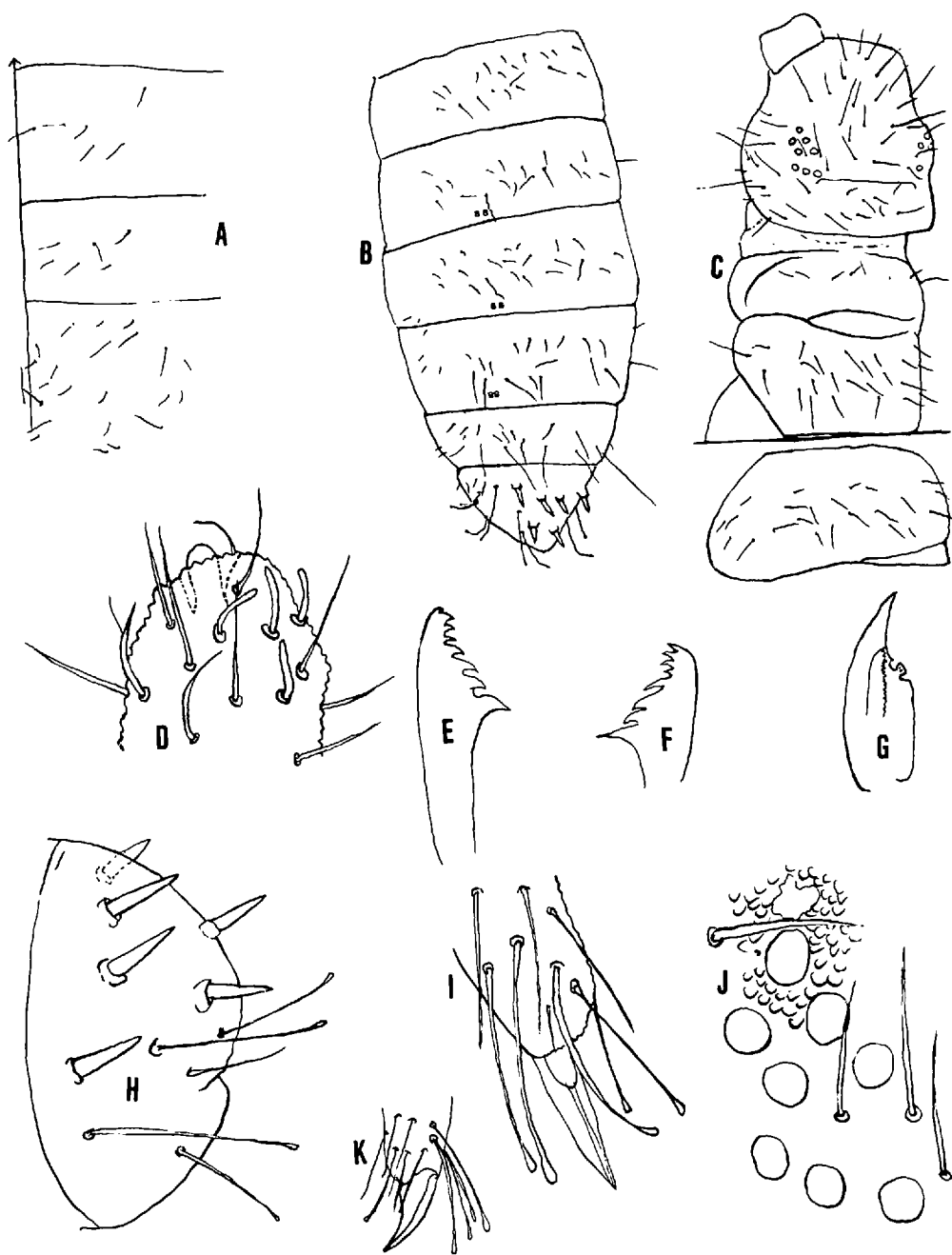


Figure 19. *Friesea carlota*. A. Ventral chaetotaxy, left side, second through fourth abdominal segments, paratype. B. Posterior dorsal and lateral chaetotaxy, paratype. C. Dorsal chaetotaxy, head, first 2 thoracic, and first abdominal segments, paratype. D. Apex of antenna, paratype. E and F. Mandibles, paratypes. G. Maxilla, holotype. H. End of abdomen, paratype. I. End of hind foot complex from inner side, paratype. J. Eyes of left side, paratype. K. Hind foot complex from side, holotype.

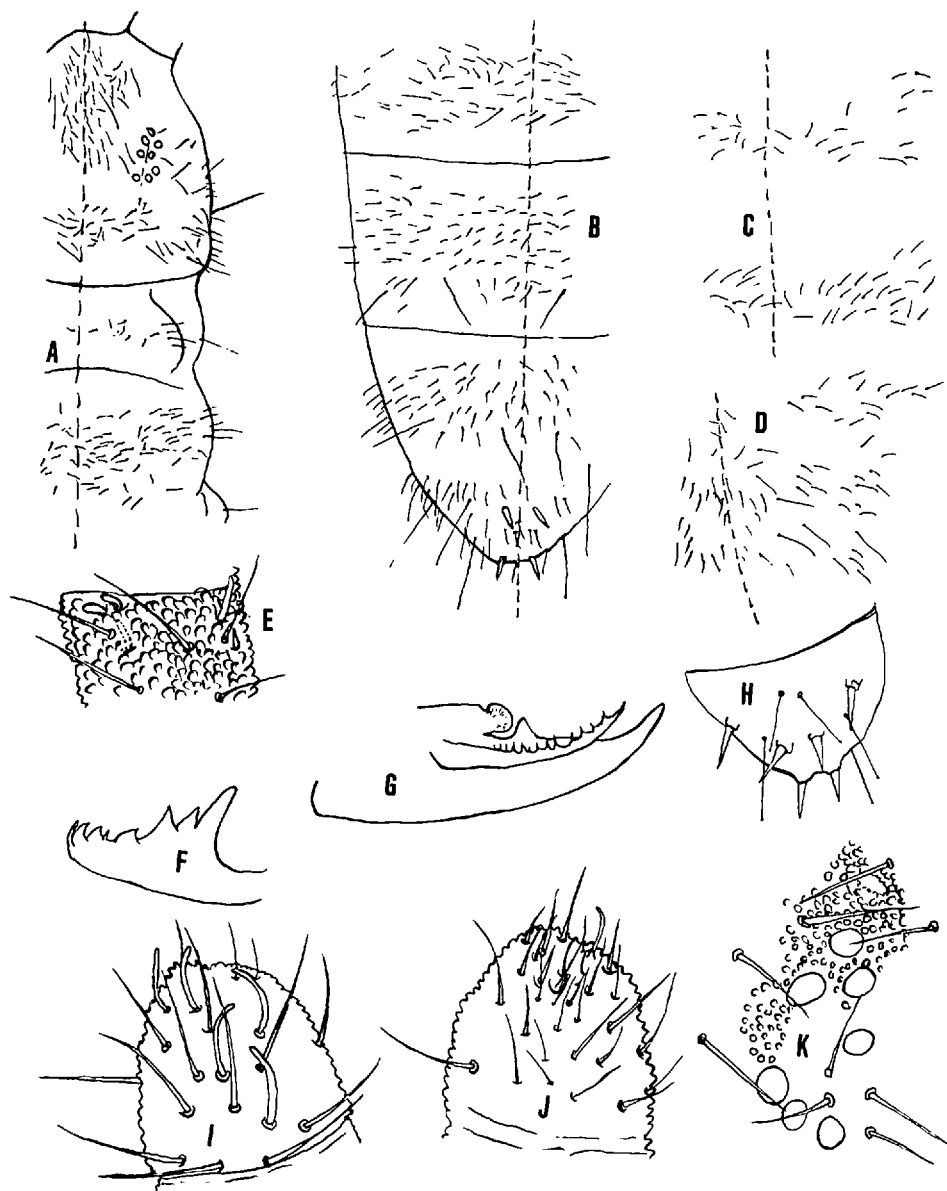


Figure 20. *Friesea rothi*. A. Dorsal chaetotaxy, head and first 2 thoracic segments, paratype. B. Dorsal chaetotaxy, last 3 abdominal segments, paratype. C. Ventral chaetotaxy second and third abdominal segments, paratype. D. Ventral chaetotaxy, fourth and fifth abdominal segments, paratype. (In Figure 20 A-D, the dotted line represents the midline). E. Apex of third antennal segments, paratype. F. Mandible, paratype. G. Maxilla, paratype. H. End of abdomen, paratype. I. Apex of antenna, dorsal view, holotype. J. Apex of antenna, ventral view, holotype. K. Eyes of left side, paratype.

Pseudanurida sawayana Schuster, 1965

Pseudanurida sawayana Schuster, Beitr. neotrop. Fauna 4: 198 (Recife, Brazil) Murphy, 1971 Pacif. Ins. 13: 49-51 (redescribed)

Puerto Rican specimens appear to match the redescription by Murphy (1971), except perhaps for the distribution of abdominal macrochaetae. The two poor

Florida specimens are generally similar but have a clear inner tooth on the unguis; it is possible that they belong to a different species.

New Localities.—Puerto Rico: Colon, Aquadilla Parque, mangrove litter, April 27, 1985 (F. Soto). Florida: Monroe Co., Long Key State Park, under and on rocks 3–6 feet below high tide mark, 5 January 1985 (K. Christiansen).

***Anurida ashbyae* new species**
Figures 21 and 22B, Table 1

Holotype.—MCZ 33321. No. 6513. Collected Monroe Co., Atlantic side of Bahia Honda Key, Florida; under stones 4–5 ft. below high tide mark, 1/8/85.

Description.—Color uniform dark blue with pale intersegmental lines. Fourth antennal segment with a trilobed bulb in a slightly subapical dorsal pit; no clearly differentiated blunt setae. Third and fourth segments less clearly demarcated than other antennal segments. Third antennal segment with 4 subapical conical pegs, one dorsal, a pair on outer dorsal surface, and one ventral. Labrum without clear papillae or lobes but with coarse tuberculation. Mandible with 4 large inner teeth, a large, thin, flexible, generally triangular basal lamella, and a supplementary outer distal dorsal tooth. Maxilla trilamellate; median lamella with a large apical tooth and 7–8 smaller posterior teeth; dorsal and ventral lamella more delicate, with 20–22 slender teeth diminishing slightly in size toward base. Labial triangle with coarsely tuberculate distal portion bearing 4+4 subequal mesochaetae, and more finely tuberculate basal portion with 8 ventral and 3 lateral setae of varying lengths. Postantennal organ with 6–8 (usually 7) lobes. Eyes 5+5, widely spaced. First and second tibiotarsi with 5+11 setae, third with 7+11; dorsal tenent hair long, outstanding, and acuminate. Unguis with clearly tuberculate base, unarmed except for inner tooth which is usually strong. Ventral tube with 6+6 distolateral setae. Female genital plate with about 28 setae in 3 very irregular rows. Male genital plate with 8 rows and about 24 files of small subequal setae. Body uniformly tuberculate; tubercles 2–3 micra in basal diameter. Plurichaetotic, with 3+3 or 4+4 macrochaetae dorsally and laterally on thorax and first 5 abdominal segments, and many smaller setae. Maximum length 3.5 mm.

Remarks.—This species is very similar to *A. maritima*; specimens from Florida identified as *maritima* by the senior author in Simberloff and Wilson, 1969 are probably *A. ashbyae*. The 2 species differ consistently in the form of the mandible: the third and fourth teeth are much farther apart in *A. ashbyae* than in *A. maritima*, and in the former the fourth tooth arises abruptly from the posterior end of a flat lamella, whereas in *A. maritima* the tooth apex is hardly set off from the lamellar base. The following table lists other differences which have been observed:

	<i>A. maritima</i> (from Massachusetts)	<i>A. ashbyae</i>
Dorsal maxillary lamella	shorter than median lamella	usually slightly longer
Teeth on median maxillary lamella	6	7–8
Setae on adult first antennal segment	13–14	16–17

The consistency of these differences should be checked on more material.

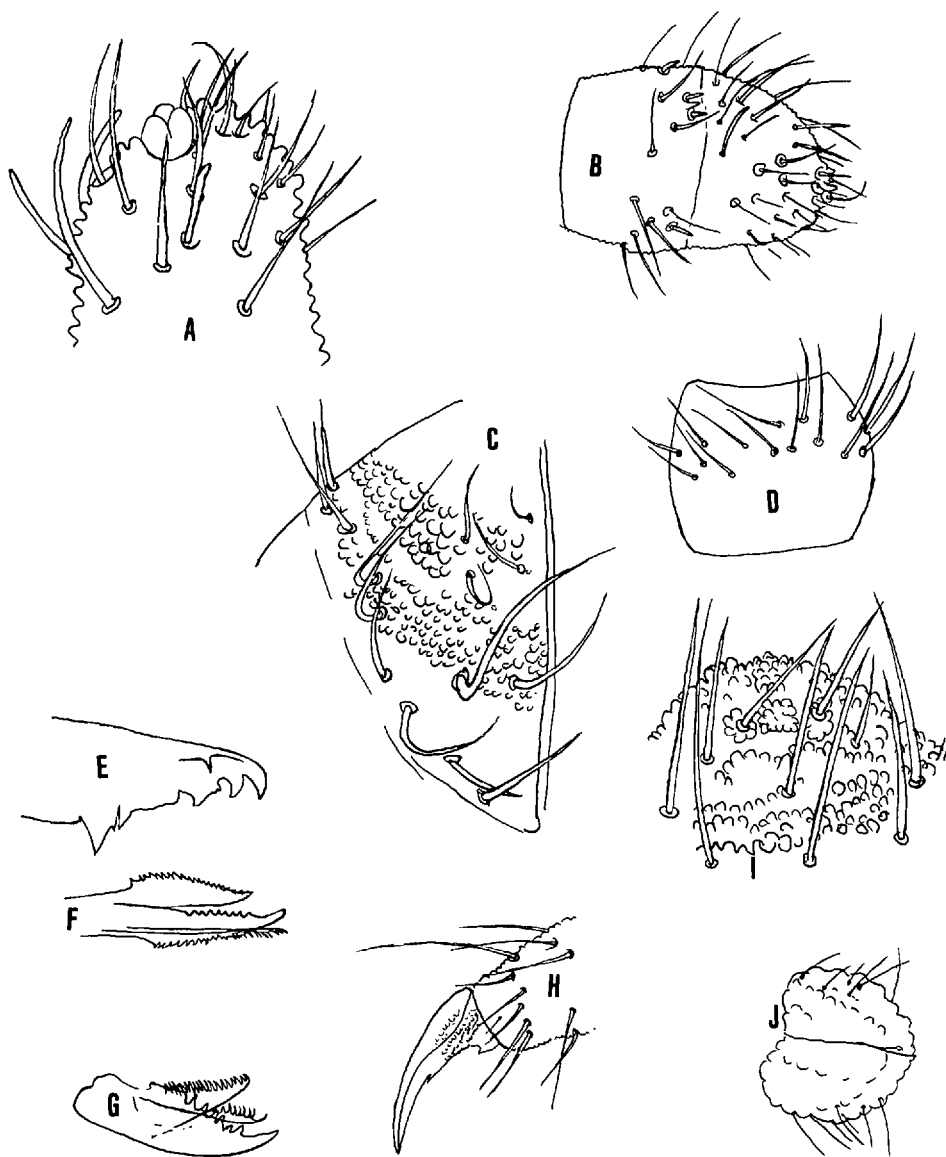


Figure 21. *Anurida ashbyae*. A. Apex of antenna, specimen from Wakiwa Springs State Park. B. Last 2 antennal segments, specimen from Pigeon Key. C. Right side of ventral labial triangle, same specimen as in A. D. First antennal segment, paratype. E. Mandible, paratype. F. Maxilla, seen on edge, specimen from Sanibel Island. G. Maxilla, specimen from Pigeon Key. H. Hind foot complex, paratype. I. Labrum, paratype. J. Ventral tube, paratype.

Habitat. —The animal is found mainly in the intertidal zone, from midtide levels to the supralittoral fringe; however, we have one record from a hammock in a palm-liveoak forest, and one from under the bark of a dead tree in a scrub oak forest.

Type Locality. —Florida: Monroe Co., Caribbean side of Bahia Honda Key, under stones 4–5 feet below high tide mark, 8 January 1985, holotype and about 60 paratypes (K. Christiansen).

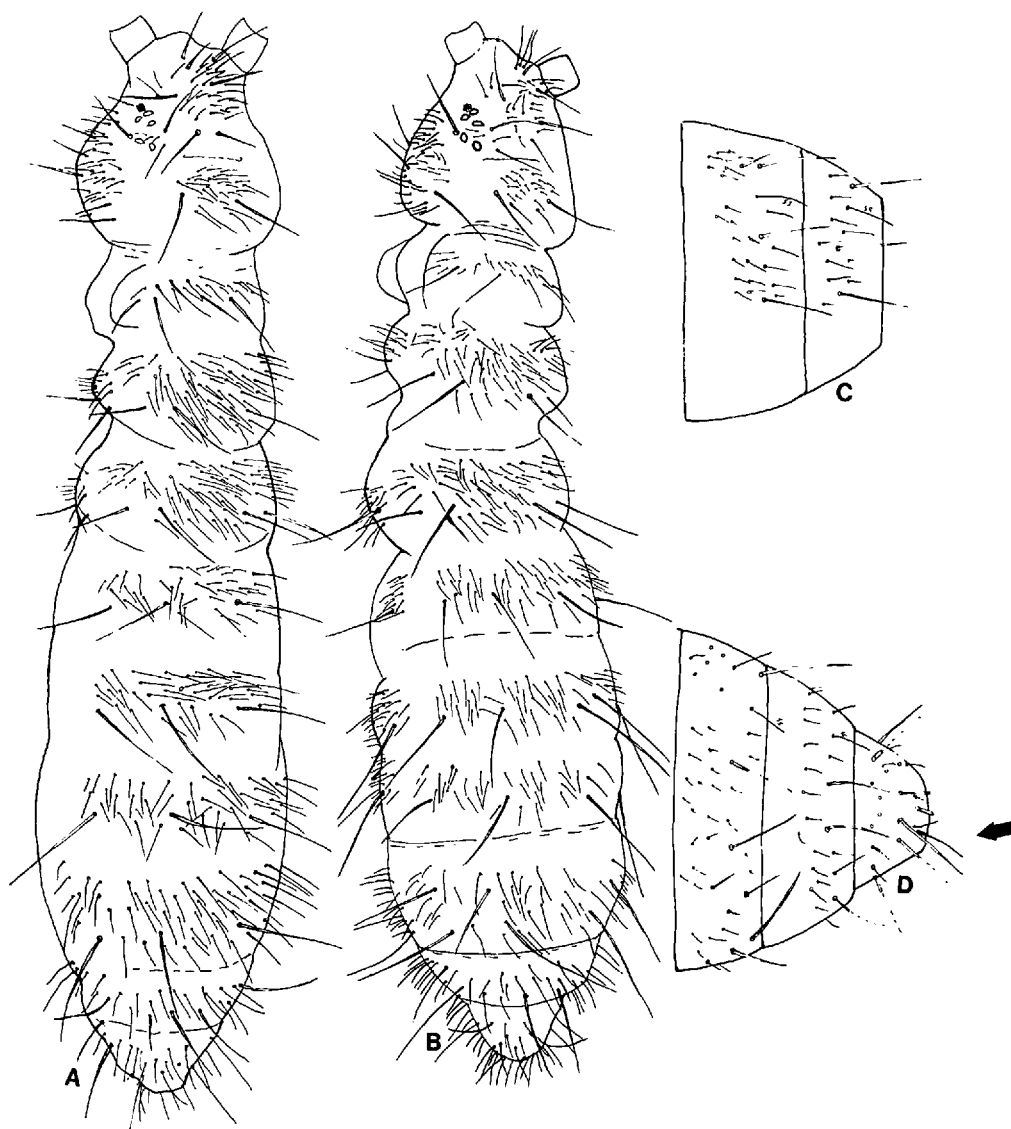


Figure 22. A. Dorsal chaetotaxy, *Anurida mara*, paratype. C and D. Variations of posterior dorsal abdominal chaetotaxy of *A. mara*. B. Dorsal chaetotaxy of *Anurida ashbyae*, paratype.

Additional Localities.—Florida: Monroe Co., Pigeon Key, 3–5 January 1985; No Name Key, Caribbean Side, 5 January 1985; Long Key, upper and Atlantic sides, 6 January 1985; Lower Matecombe Key, Atlantic side, 6 January 1985; Lee Co., Sanibel Island, Ding Darling Wildlife Refuge, 8 January 1985; causeway to bridge leaving Sanibel Island, 10 January 1985. Seminole Co., Wakiwa Springs State Park, near Orlando, 12 January 1985 (K. Christiansen).

***Anurida mara* new species**

Figures 22A, C, and D and 23, Table 1

Description.—Color dark blue except for pale blue lines on intersegmental membranes. Fourth antennal segment with bulb projecting from a shallow subapical

pit and 4–6 large setae which are thicker, more strongly curved, and less gradually acuminate than others, but still not clearly blunt. Third and fourth segments only weakly separated. Apex of third antennal segment with 2 dorsolateral rods in deep, separate pits, a ventral rod on a papilla, and an exposed dorsal and more basal peg, somewhat smaller than others. Buccal cone slightly projecting. Labrum with a median papilla, often apically indented, and many large distal tubercles. Mandible with 5 inner teeth, a small tooth on the dorsal surface near the outer margin, and commonly 1–2 very small teeth in the notches between the last 3 inner teeth. Median lamella of maxilla with 6 inner teeth and a blunt, dorsally projecting basal tooth; dorsal and ventral lamellae each with about 20 slender teeth. Labium with 7+7–9+9 setae. Postantennal organ with 6–8 (usually 7) lobes in a circle. Eyes 5, widely spaced; largest eye 1–1.3 times diameter of postantennal organ in longest measurement. First and second tibiotarsi with 8 basal and 11 distal setae, third with 7 and 11; the 3 dorsal distal setae are weakly clavate and 1.5–2 times length of inner edge of unguis. No inner tooth or basal tubercles on unguis. Ventral tube with 4+4 or 5+5 distolateral setae. Female genital plate with about 22 setae in 3 rows and a weak median pair near the lip edge. Male genital plate with 8–9 rows and about 20 files of small subequal setae; the venter of the fifth abdominal segment has many small setae just in front of the plate. Body plurichaetotic with one row of 3+3 or 4+4 weakly serrate, acuminate macrochaetae on each segment. Maximum length 3 mm.

Remarks.—This species is similar to both *A. ashbyae* and *A. maritima*, but differs from both, and from most species of *Anurida*, in having clavate tenent hairs. The chaetotaxy of this species appears to be quite variable. The ventral rod on the third antennal segment is sometimes absent.

Type Locality.—Costa Rica: near Quepos-Manuel Antonio, on damp rocks in intertidal zone, 15–21 February 1976. Holotype and 25 paratypes (Roth and Schoepfer).

Additional Locality.—Costa Rica: south of Dominical, on intertidal rocks.

Anurida (Anurida) maritima (Guerin), 1838¹

The discovery of two new, very similar, American littoral species of *Anurida* raises questions about earlier records of *A. maritima* which cannot be answered without additional material. The old Florida record of L  nberg (1894) is very likely *A. ashbyae*. There is only one old West Coast record of *A. maritima* (Spencer, 1948); the species is keyed in works on the California fauna (Light, 1954; D. B. Scott, 1956), but no actual records are given, and we have seen no specimens. An inland record from Oregon (H. G. Scott, 1963) hardly needs serious consideration.

Onychiurus (Protaphorura) debilis (Moniez), 1889

New Locality.—California: Los Angeles Co., Ballona salt marsh.

Archisotoma besselsi (Packard), 1877

The discovery of *A. interstitialis* in the Caribbean and on the West Coast suggests that earlier, southern records of this species also need reevaluation. Two inland records, from South Carolina (Metz and Dindal, 1975) and Mexico (Hepburn and Ross, 1964) appear unlikely. Christiansen and Bellinger (1980), following Bacon

¹ For references to this and other previously recorded species, see Christiansen and Bellinger, 1980–1981.

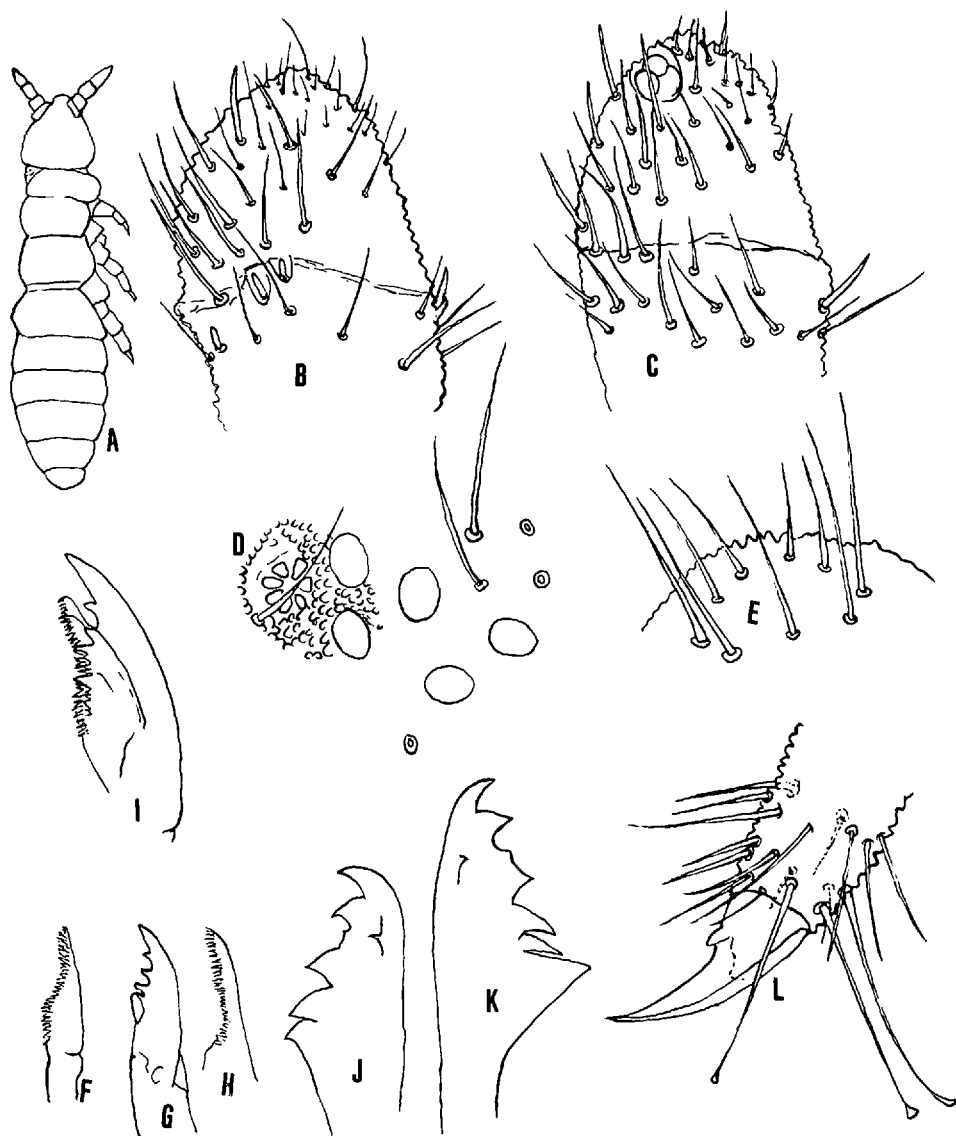


Figure 23. *Anurida mara*. A. Habitus, paratype. B. Antennal apex, specimen from south of Dominical. C. Same, ventral view. D. Eyes and postantennal organ, same specimen, left side. E. Labrum, paratype. F, G, and H. Ventral, median, and dorsal lamellae of maxilla, paratype. I. Maxilla, specimen from south of Dominical. J. Mandible, same specimen. K. Mandible, holotype. L. Hind foot complex, same specimen.

(1912), listed *A. besselsi* from southern California, and suggested that *Proisotoma laguna* Folsom, 1937 (= *Isotoma bidenticula* of Bacon, 1912, not of Guthrie, 1903) is also this species. In fact it now seems likely that our earlier record and Bacon's "besselsi" are *A. interstitialis*; *P. laguna*, from Bacon's description, is different, but the species has never been rediscovered.

Archisotoma interstitialis Delamare, 1954

Archisotoma interstitialis Delamare, Vie Milieu 4: 308 (Mediterranean); Nagano et al., 1981; Gruia, 1983

Archisotoma renaudi Delamare, 1956, Vie Milieu 7: 398 (Bimini I.)

California specimens are from a salt marsh; Mexican collections are all from seaweed in the intertidal zone.

New Localities.—California: Los Angeles Co., Ballona Salt marsh, 4 March 1981. Mexico: Sonora, Punta Chueca, 18 January 1974; Punta Cirio, 20 March 1974; San Carlos, 30 March 1974; Tide Pool Beach.

Axelsonia tubifera Strenzke, 1958

This is one of the commonest littoral species of the Keys. The collections are all from the mid-littoral zone on and under rocks.

New Localities.—Florida: Monroe Co., Long Key, No Name Key, Lower Matecumbe Key, Pigeon Key. Lee Co., Sanibel Island Causeway.

Isotoma (Psammisotoma) dispar new species

Figure 24, Table 1

Holotype.—MCZ 33322. No. 6513 Pigeon Key, Atlantic Side, Monroe Co., Florida, on rock among roots of mangrove-sifting, 1/4/85.

Description.—Color gray due to scattered black pigment granules; membranous areas white. Fourth antennal segment with a short, unforked pin seta and a short, rodlike subapical organ. Apical organ of third antennal segment obscure, of 5–6 ovoid pegs in separate shallow grooves. Ventral sensory setae of first antennal segment small and acuminate. Labrum with 2 small conical contiguous papillae and without ventral ciliations. Maxilla very complex, with 6 or 7 blades; the outermost is heavy and has 3 large apical teeth; each of the other 2 largest blades consists of a series of thick overlapping, finely serrate lamellae. Maxillary outer lobe with 3 sublobal hairs and lacking a basal seta. Postantennal organ broadly oval, with an incomplete median listel, and about 1.5 times as long as diameter of nearest eye. Eyes 6+6 or 8+8; eyes G and H when present are very small and without clear corneas. Second tibiotarsus with an outer pair of curved sparsely serrate setae. Tenent hair on all feet acuminate and unusually fine. Unguis with strong lateral teeth but no inner tooth. Unguiculus without a corner tooth; inner edge concave distally. Ventral tube with 3+3 anterior, 5+5 distolateral, and 1+1 posterior setae. Manubrium with 5–6 distomedial spinelike setae on the anterior face; apical thickening with a free tooth. All dental setae short and acuminate; inner ventral setae more slender and distal ventral setae distinctly longer than others; dens slightly swollen at base of mucro. Mucro tridentate, without basal seta. Clothing of smooth, acuminate setae; 2 pairs of bothriotricha near the anterior margin of the fourth abdominal tergite. Maximum length 1.5 mm.

Remarks.—In many respects this species resembles *Isotoma maritima* Tullberg, 1871; the feathered midtibiotarsal setae in particular suggest a close relationship between them. The presence of bothriotricha distinguishes *I. dispar* from other *Isotoma* species. In this character and others it resembles *Psammisotoma kingae* Greenslade and Deharveng, 1986; *P. kingae*, however, has a somewhat different maxilla, only 2 spinelike setae on the apex of the manubrium, and no lateral

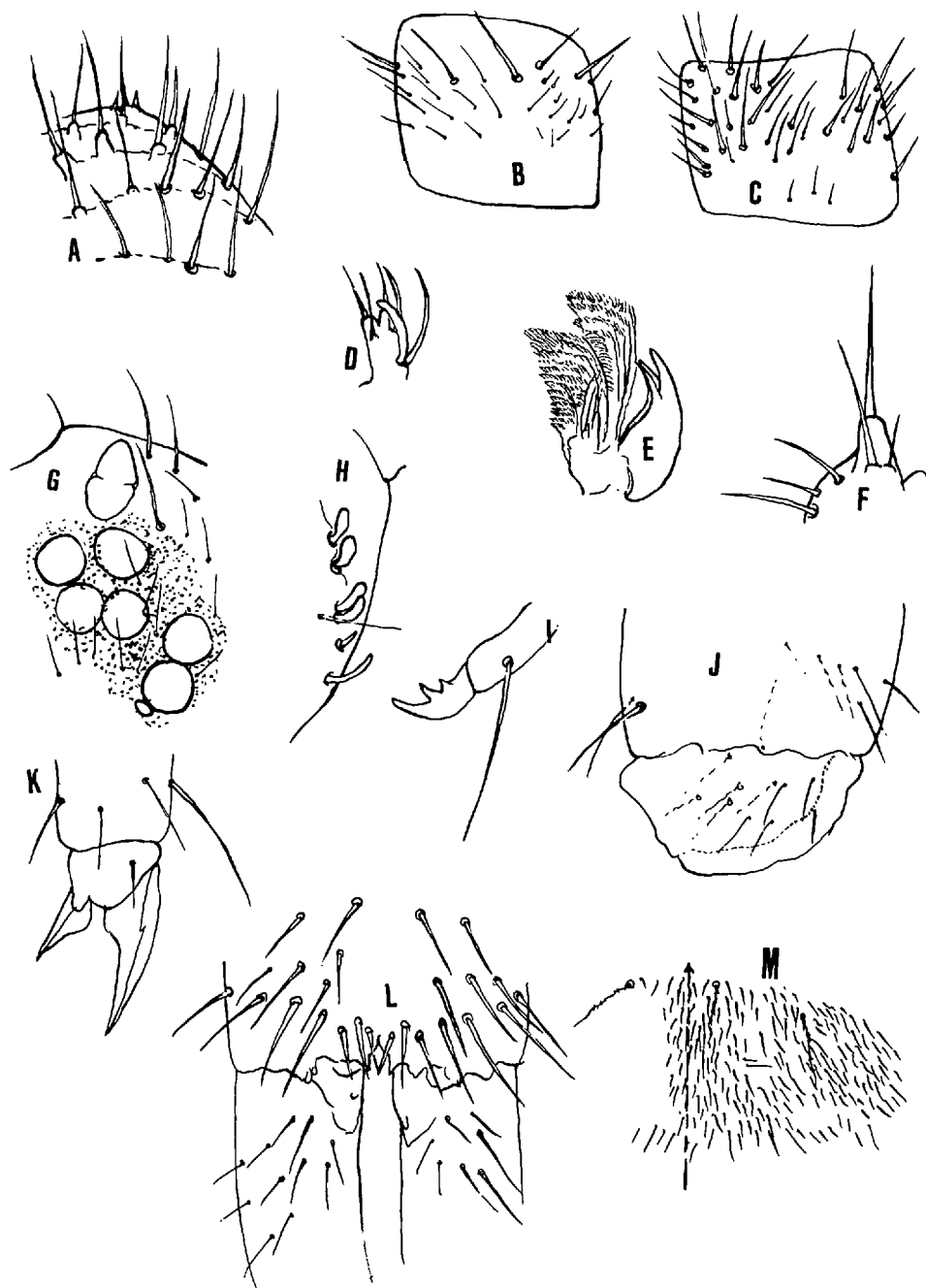


Figure 24. *Isotoma (Psammisotoma) dispar*. A. Labrum, paratype (dotted lines link setae in same row). B. Ventral surface of first antennal segment, holotype. C. Dorsal surface of first antennal segments, holotype. D. Left labial appendage, paratype. E. Maxilla, paratype. F. Submaxillary lobe, paratype. G. Right eyepatch and postantennal organ, paratype. H. Apex of third antennal segment, paratype. I. Mucro, paratype. J. Apex of ventral tube, holotype. K. Foot complex, paratype. L. Ventral surface of apex of manubrium and base of dens, paratype. M. Dorsal chaetotaxy of right side of fourth antennal segment, paratype.

ungual teeth. We did not find the glands at the bases of all body setae as described in *P. kingae*.

We do not believe that the presence of bothriotricha alone justifies a generic separation between *dispar* and *Isotoma*, particularly in view of its resemblance to *I. maritima*. Until the *Isotoma* complex can be reclassified on phylogenetic grounds, it may be convenient to recognize the peculiar characters of these species by use of the subgenera *Halisotoma* (for *maritima* and *marisca* n. sp., below) and *Psammisotoma* (for *kingae* and *dispar*).

Habitat.—Found under rocks in the intertidal zone and in wrack and litter at the high tide limit.

Type Locality.—Florida: Monroe Co., Pigeon Key, 3–4 January 1985. Holotypes and 5 paratypes (K. Christiansen).

Additional Locality.—Florida: Monroe Co., Windley Key, 11 December 1985 (M. Culik).

***Isotoma (Halisotoma) marisca* new species**

Figure 25, Table 1

Isotoma maritima Tullberg of Nagano et al., 1981

Holotype.—MCZ 33320. No. 6961 Ballona Wetlands, Playa del Rey, Los Angeles Co., California from soil sample in salt marsh, 3/4/81.

Description.—Color pale gray-blue; mounted specimens unpigmented. Fourth antennal segment with minute, peglike subapical organ and 3 slightly curved blunt setae; no clearly differentiated pin seta. Apical organ of third antennal segment composed of 2 blunt pegs in separate pits. First and second antennal segments without modified setae but each with a triangular spinelike projection on the inner ventral apex. Labrum with 4 upward curling flat flanges; without ventral ciliations. Prelabral setae 4-4-4, all smooth. Maxilla with 6 blades, the largest consisting of 8 overlapping lamella; maxillary outer lobe with 2 sublobal hairs and a basal seta. Postantennal organ broadly oval, undivided, and about twice as long as diameter of nearest eye. Eyes 8+8 with posterior eyes smaller. Second tibiotarsus with 1-2 outer serrate setae. Tenent hair fine and acuminate. Unguis without teeth. Unguiculus concave internally. Ventral tube with 3+3 anterior setae, 2+2 distolateral setae, and 6 posterior setae in 2 straight rows. Corpus of tenaculum with 4-6 setae. Manubrium with 5 distomedial spinelike setae on anterior face; apical thickening without free tooth. Dental setae all short and acuminate; dorsal setae slightly more slender than others and confined to basal half of dens; subapical dental seta exceeding apex of mucro. Mucro tridentate, with basal teeth at same level and subequal; apical tooth slightly larger than others. Sixth abdominal segment weakly separated from fifth. All body setae smooth and acuminate; longest posterior setae about twice as long as inner edge of unguis. Maximum length 1 mm.

Remarks.—This species was originally determined as *I. maritima* Tullberg, but it does not agree fully with any descriptions of *maritima*. Material from Tullberg's Swedish localities has never been redescribed, and the best later descriptions (Strenzke, 1955; Palissa, 1969; Poinso, 1971) do not entirely agree. For example, the peculiar projections of the basal antennal segments have been described only by Palissa, from German Baltic Coast (but inland) specimens; Palissa also shows the basal mucronal teeth as subequal and the unguis as having lateral teeth, which

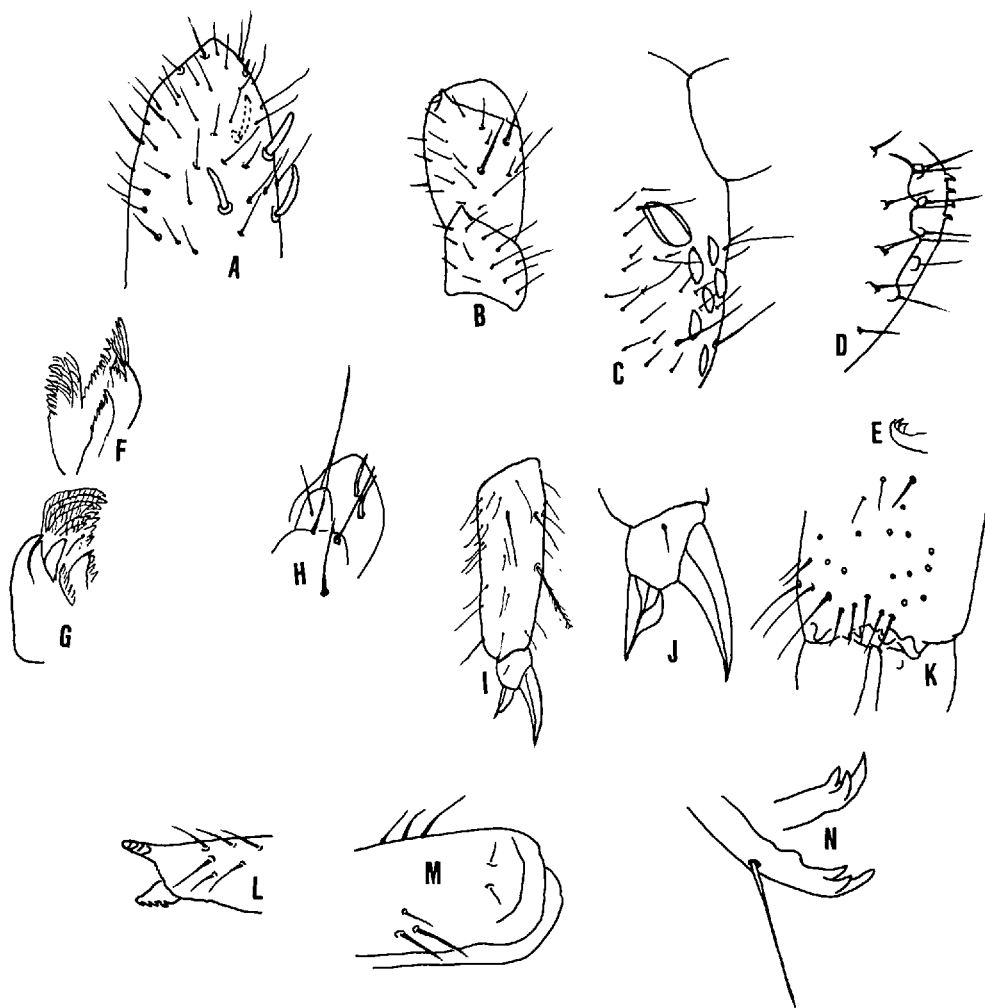


Figure 25. *Isotoma (Halisotoma) marisca*. A. Apex of antenna, paratype. B. First and second antennal segments showing apical angles, paratype. C. Postantennal organ and large eyes of right side, paratype. D. Labrum, seen from above at an angle, paratype. E. Apex of labrum seen from side, paratype. F. Maxilla, seen from angle, paratype. G. Maxilla in plan view, paratype. H. Premaxillary lobe, paratype. I. Midtibiotalarsus, paratype. J. Foot complex, paratype. K. Ventral surface of apex of manubrium, paratype. L. Tenaculum, paratype. M. Ventral tube seen from side (composite). N. Mucrones, paratype.

are differences from other descriptions and, in the case of the last character, from the California specimens. Since it is at present impossible to determine which of the descriptions of European material applies to Tullberg's species, we are describing the California specimens as a new species.

All specimens we have seen are immature; the second serrate tibiotarsal seta may be more evident in adults. A single poor specimen from Sonora may also belong here, but the presence of some differences make its position uncertain.

Type Locality.—California: Los Angeles Co., Ballona Wetlands, Playa del Rey, from soil sample in salt marsh, 4 March 1981. Holotype and 4 paratypes (C. Nagano).

Actaletes new species

This species is being described elsewhere (F. Soto, *in litt*).

Seira fulva (Schött), 1896

Figure 26

Lepidocyrtus fulvus Schott: Proc. Calif. Acad. Sci. (2)6:173 (Magdalena Is.): *Seira fulva* Palacios-Vargas, 1984: 71

Description.—Color yellow, eyes and interantennal spot dark blue, last 2 antennal segments and sometimes distal parts of the legs pale blue; fully clothed specimens have a brownish cast produced by the layers of scales. Fourth antennal segment with bilobed apical bulb, sometimes withdrawn into antennal apex; segment not annulate or with clear whorls of setae. Apical organ of third antennal segment composed to 2 basally bent blunt pegs, about 0.0017 mm in diameter. First antennal segment, basal half of second, and most basal part of third scaled. Labral papillae blunt, without setae or micropapillae. Labial triangle setae all ciliate; M_1 , M_2 , and E all large and subequal; R at least half as long as other setae. All eyes large, but A and sometimes E clearly larger and G and H smaller than others. Head broadly oval to round in dorsal view. Coxae, femora, trochanters, and basal halves of the tibiotarsi scaled; legs with small reclinate or outstanding setae and some much larger outstanding setae. Trochanteral organ without clear arms, triangular, with about 12 setae. Tenent hair strongly clavate. Unguis with strong basal lateral teeth and 3 small inner teeth, of which the distal tooth is subequal to or slightly larger than the basal pair. Unguiculus strongly excavate internally beyond juncture of inner lamellae. Ventral tube with anterior face basally scaled and with 2+2 ciliate macrochaetae and 4+4 ciliate mesochaetae; distolateral patches each with about 9 smooth and 13–14 ciliate setae. Dens with apical non-crenulate section subequal in length to mucro. Macrochaetae are almost all large, apically angulate, ciliate setae. Scales pale brown, broadly oval, with short surface striations or microsetae. Maximum length 2 mm.

Remarks.—This species had not been recorded since the original, inadequate description. The similarity in pattern, foot, and mucro to the original description and the locale and marine habitat leave little doubt that our specimens belong to Schött's species. This and the following species are the only known members of *Seira* with the unguiculus distally excavate. The apical bulb of the fourth antennal segment is sometimes very difficult to see, and may sometimes be unlobed. The anterior chaetotaxy shows no significant variation in the samples we have examined.

Habitat.—Found on sandy beaches and mud flats on seaweed, and on tide pools.

Type Locality.—Mexico: Baja California Sur, Magdalena I.

Additional Material and Localities.—Mexico: Sonora, Punta Cirio, 24 September 1973, Campo Dolar, February 26, 1981. *S. coloraditos*, April 21, 1975.

Seira nicoya new species

Figure 27, Table 1

Description.—Background white; blue pigment in dark specimens laterally on trunk, in transverse bands on front of second thoracic segment and hind margin of third through sixth abdominal segments, and covering antennae, legs, and manubrium; head with interantennal spot and large cheek patches; pale specimens with pigment limited to antennae, eye patches, and lateral parts of body. Fourth

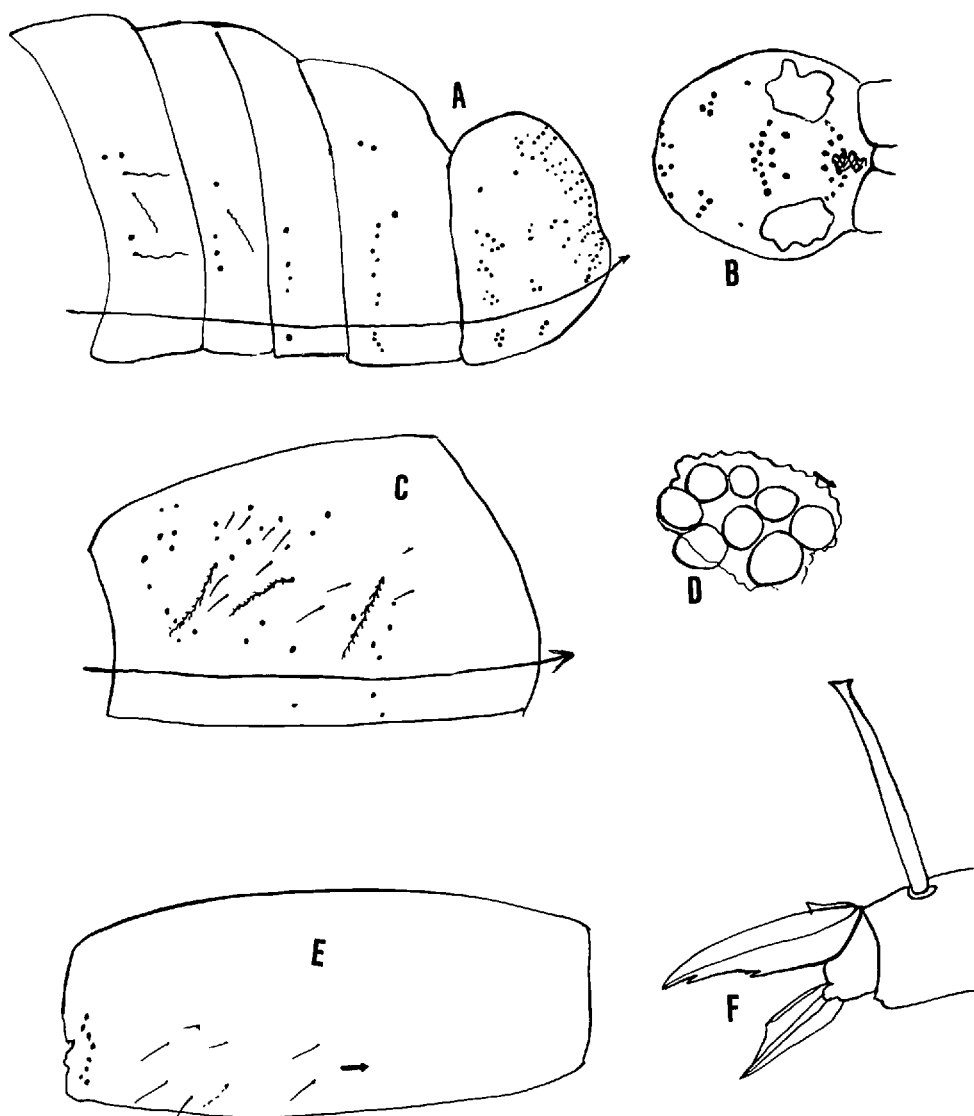


Figure 26. *Seira fulva* (all figure 1.s of specimens from Punta Cirio). A, B, and C. Dorsal chaetotaxy. D. Right eyepatch. E. Venter of manubrium showing macrochaetae. F. Hind foot complex.

antennal segment with bilobed apical bulb, often difficult to see; without subsegments or clearly whorled setae. Apical organ of third antennal segment of 2 short, curved, cylindrical pegs in shallow grooves. First, second, and basal half of third antennal segments scaled. Labral papillae, blunt, without micropapillae or microsetae. Labial triangle setae of posterior row all large, ciliate, and subequal except for seta R which is about half as large as others. Eyes A, B, and E generally larger than C, D, and F, which are larger than G and H. Trochanteral organ without clear arms, triangular, with about 12 setae. Hind tibiotarsus with outer and inner elongate differentiated setae, larger and thicker than others and respectively 2.8–3.2 and 2–2.5 times as long as inner edge of unguis. Tenent hair

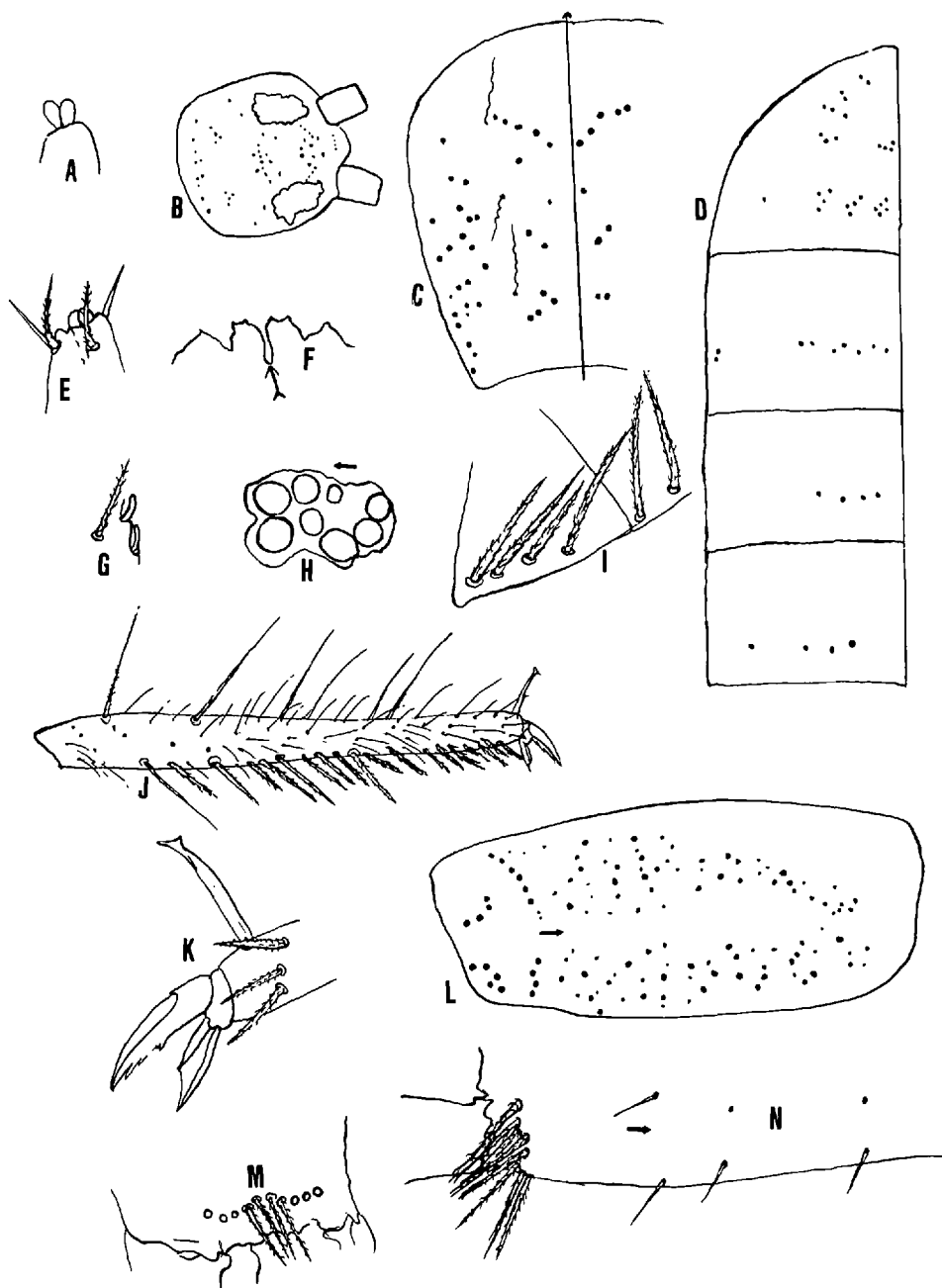


Figure 27. *Seira nicoya*. A. Apex of antenna, paratype. B. Cephalic chaetotaxy, paratype. C. Dorsal chaetotaxy of fourth abdominal segment, paratype. D. Chaetotaxy of thorax and first two abdominal segments, paratype. E. Apex of antenna, paratype. F. Labral papillae, paratype (arrow marks median groove). G. Apical organ of third antennal segments, paratype. H. Eyes of left side, holotype. I. Basal setae of labial triangle, paratype. J. Hind leg, paratype. K. Hind foot complex, paratype. L. Dorsal surface of manubrium with setae removed, paratype. M. Apex of manubrium seen from below (only medial setae shown), paratype. N. Ventral surface of manubrium from side, paratype (2 microsetae missing).

strongly clavate. Unguis with strong lateral basal teeth and 4 inner teeth, the apical tooth much longer than the others. Unguiculus apically excavate and sharply truncate beyond juncture of inner lamellae. Ventral tube with 2 macrochaetae and 4 mesochaetae on anterior face and about 6 smooth and 14 ciliate setae in each distolateral patch. Dens with apical non-crenulate part 1.5–2 times as long as mucro. Scales yellowish and oval, with short, coarse striations. Maximum length 2.5 mm.

Remarks.—Few dorsal macrochaetae remained on the specimens we saw, but those present were as in *S. fulva*. The 2 species are similar, but may be distinguished by the chaetotaxy of the second thoracic segment, pattern, ungual teeth, and several minor features. The truncate unguiculus distinguishes them from all other *Seira* sp.

Type Locality.—Mexico: Sonora, Campo Dolar, south of Puerto Tepoca, February 26, 1981, intertidal zone, holotype and 26 paratypes (V. Roth).

Additional Locality.—Mexico: Sonora, Tastiota, April 5, 1986 (V. Roth).

Pseudosinella lahaiensis Christiansen and Luther, 1986

Pseudosinella lahaiensis Christiansen and Luther: Proc. Haw. Ent. Soc. 26: 45 (Maui)

This form is found under rocks and in litter in the mid and upper littoral zones; it was previously known only from the Hawaiian Islands.

New Locality.—Mexico: Sonora, Punta Cirio, 24 September 1973.

ECOLOGY

Those species represented in our collections by adequate material appear to inhabit all levels from midlittoral to littoral fringe. Though they are most often found in rocky areas, they also occur on sandy and muddy beaches wherever there are stable solid surfaces; they are often found on tide pools and sometimes in worm burrows.

Little has been written about the diets of marine Collembola. We examined the gut contents of the new forms discussed in this paper, as well as some specimens from older collections. This at least provides a guide to what has been ingested, although materials actually used in nutrition may no longer be evident. Table 2 summarizes our findings. It should be noted that the first data column only records numbers of observations, since specimens were entered here only if there were no identifiable items in the gut contents; most specimens had large amounts of unidentifiable material in addition to recognizable elements.

Clearly there are both taxonomic and regional differences in the gut contents. Recognizable elements are so uncommon in specimens of *Anurida* and *Pseudanurida* that it appears likely that their ingestion was accidental. Specimens of one species of *Friesea* also lacked most recognizable elements, while in the remaining species we examined such elements were usually present. Diatoms are more commonly found in specimens from Mexico than from other areas, and regional differences in food are also suggested by the data for *Archisotoma interstitialis*.

There is considerable individual variation, even in specimens from the same collection. Some minor elements were not entered in the table. Three specimens of *Seira* contained setae of mites or insects, in one case belonging to another species of Collembola. A few specimens contained one or two fragments of fungal mycelium; two had what appeared to be unicellular green algae.

Table 2. Observed gut contents

Region	Species	Only gut contents clear but undifferentiable	Diatoms	Misc. spores	Fungus spores	Mineral grains and cuticle fragments	Annelid remains	Fragments of protozoan tests-pellicle and diatoms
Florida	<i>Anurida ashbyae</i>	(14)	A (1)	A (2)	—	—	—	A (1)
Costa Rica	<i>Anurida mara</i>	(8)	—	—	—	—	A (1)	—
Florida	<i>Brachystomella honda</i>	—	—	C (3)	B (2)	—	—	—
Florida + Mexico	<i>Pseudanurida sawayana</i>	(5)	A (1)	—	—	—	—	—
Puerto Rico	<i>Friesia rothi</i>	(2)	B (3)	A (2)	A (1)	A (1)	B (2)	B (1)
Mexico	<i>Friesia carlota</i>	(2)	—	—	—	—	A (1)	A (1)
Mexico	<i>xenylla (H.) affinis</i>	—	B (2)	A (1)	A (1)	—	—	A (2)
Florida	<i>Archisotoma interstitialis</i>	—	C (11)	—	—	A (2)	—	—
Mexico	<i>Archisotoma interstitialis</i>	(2)	A (2)	—	—	—	—	—
California	<i>Archisotoma interstitialis</i>	(2)	A (1)	—	—	B (3)	—	—
Puerto Rico	<i>Axelsonia tubifera</i>	(1)	B (7)	A (2)	—	A (5)	—	A (3)
Florida	<i>Isotoma (P.) dispar</i>	(1)	A (4)	A (3)	—	C (7)	—	B (7)
Florida	<i>Isotoma maritima</i>	(2)	A (2)	A (3)	A (1)	A (2)	—	—
Mexico	<i>Seira fulva</i>	(3)	C (13)	B (4)	A (1)	B (9)	—	A (2)
Mexico	<i>Pseudosinella lahaiensis</i>	—	A (1)	—	—	B (1)	—	A (1)
Totals (letters indicate abundance type, numbers in parentheses indicate number of individuals seen)								
	C (32)	(24)	(3)	(0)	(7)	0	—	—
	B —	(12)	(4)	(2)	(13)	(8)	—	—
	A —	(10)	(13)	(4)	(10)	(10)	—	—
Grand totals	32	46	20	6	30	18	—	—

A—Never more than a minor element in the digestive tract.

B—Sometimes present in abundance.

C—Usually present in abundance.

Numbers in parentheses are number of individuals seen with this condition.

BIOGEOGRAPHY

Most of the species listed here are known so far only from this region. Comparison with the fauna of other regions is handicapped by our limited knowledge of the littoral Collembola of most parts of the world. The similarity of the Atlantic coast fauna of Europe and North America is evident: *Hypogastrura litoralis*, *Anurida maritima*, *A. calcarata*, *Archisotoma besselsi*, and *A. polaris* are shared, and *Onychiurus dentatus* and *O. litoreus* have close European relatives. The records of *Onychiurus debilis* from California and Alaska (Christiansen and Bellinger, 1980) might indicate a true faunal connection or might be the result of accidental introductions.

Axelsonia tubifera and probably *Actaetes* represent American elements in the fauna. The former has been recorded only from Brazil and now Florida, but also occurs in Jamaica (Bellinger, unpublished). The species of *Actaetes* appear to be localized; the genus extends to South America, the Caribbean (Bellinger, 1962; Soto, unpubl.), and there is one species in the English Channel, which may be explained by Gulf Stream drift.

A Pacific Ocean element may include *Pseudosinella lahainaensis* (also in Hawaii) and *Oudemansia* (extending into the Indian Ocean). A number of species or genera are probably pantropical. They include *Xenylla affinisformis* (Mediterranean, Azores, Australia, and West Africa—as *X. mangle*), *Pseudanurida sawayana* (Brazil, West Africa, and Indian Ocean), and probably *Archisotoma interstitialis* (Mediterranean, Bahamas—as *renaudi*—Puerto Rico, and the Pacific Coast). *Isotoma dispar* and *Coenaletes caribaeus* Bellinger, 1985, from Guadeloupe, both with their only close relatives in New Guinea, also suggest the existence of a very imperfectly collected pantropical fauna.

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Holotypes of the Pacific species will be deposited in the California Academy of Sciences; those of the Atlantic species, in the Museum of Comparative Zoology, Harvard University.

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* These papers contain actual records of Collembola from the littoral zone of the region.

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